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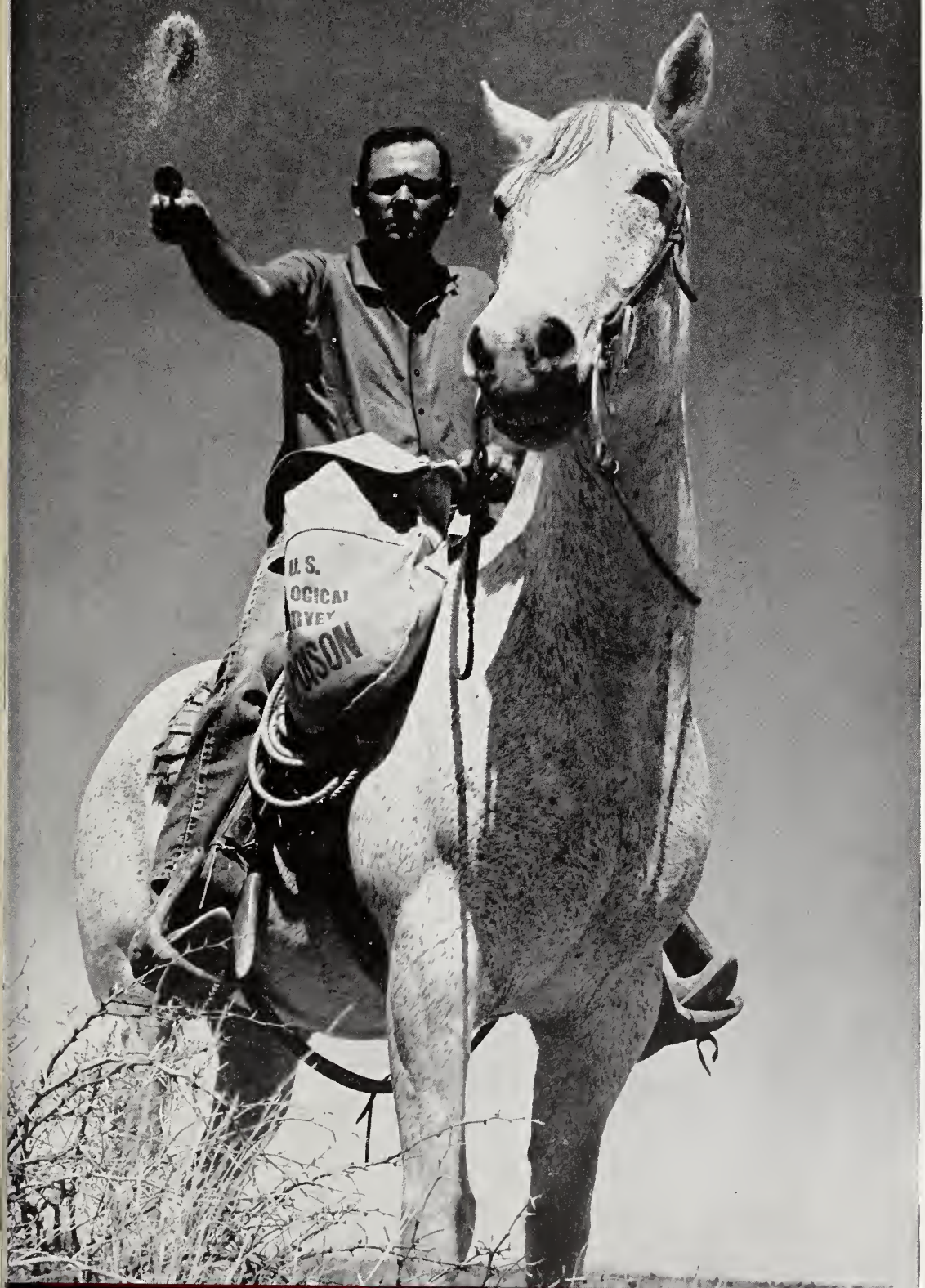

AGRICULTURAL
Research

October 1965/Vol. 14, No. 4

Preparing Pioneers

How do scientists train for basic research such as that conducted at ARS pioneering research laboratories?

These laboratories are manned today by experts in their fields—who have advanced degrees in a wide variety of scientific disciplines—and who have achieved outstanding research records.

One approach young investigators of unusual ability can take is through ARS Postdoctoral Research Associateships, conducted in association with the National Academy of Sciences—National Research Council.

Of 41 appointed to the program during its first 4 years (1961 through 1964), 8 have become permanent pioneering or basic research scientists, and 12 have received added consideration through extended appointments. Sixteen appointed in 1965 are still serving their first year.

What type of research do they do? Consider the associateships for 1966. They will be in cytopathology, entomology, mineral nutrition of plants, human nutrition, plant physiology, plant virology, biochemistry, immunology, molecular virology, cellulose chemistry, organic chemistry, microbiological chemistry, physical chemistry, oilseed protein chemistry, turpene chemistry, plant histochemistry, and biophysics.

Those young men and women selected next year will work in California, Florida, Louisiana, Maryland, New York, Pennsylvania, or Washington, D.C. They will aid seasoned scientists in their search for answers from beyond the outer limits of present-day knowledge.

What are the physical, chemical, and molecular properties of proteins? What is the light action that controls plant growth and development? What are the functions and metabolism of human nutrients?

Answers to questions like these will fuel the fires of applied research—and develop the means for tomorrow's better living for all Americans.

EDITOR'S NOTE: For additional information, write the Fellowship Office, NAS–NAC, 2101 Constitution Avenue NW., Washington, D.C. 20418. Approved applications must be received before February 1, 1966.

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ABOUT THE COVER—Range aid J. E. Stovall applies 25 percent fenuron pellets to a mesquite bush. Application, which requires no special equipment—other than a horse, a spoon, and a bag—must be made just prior to or in the early part of an expected rainy season.

Controlling Honey Mesquite

ARS scientists develop methods to curb bush invasion of valuable grassland areas of the Southwest

■ ARS scientists at the Jornada Experimental Range in southern New Mexico long have faced a thorny problem: How to stem invasion of semi-desert areas of the Southwest by honey mesquite (*Prosopsis juliflora* var. *glandulosa*).

Mesquite poses a serious threat to livestock production on some 93,000,000 acres of valuable grassland in New Mexico, Texas, Arizona, Oklahoma, and California. Its increase has been persistent. On the Jornada Range, for example, mesquite-dominated land climbed from 23.5 percent—or 33,888 acres—in 1915 to 50.3 percent—or 72,699 acres—by 1963.

This troublesome bush—which is spread by seed—robs the grasses of moisture in the soil. Once the grass cover is reduced, spring winds blow sand into dunes around the plants. Rabbits and rodents accelerate the spread as they make their homes in the bushes and work the seed out into adjacent grasslands.

Reseeding of grass often is not successful because of high surface soil temperatures and poor moisture conditions in the arid Southwest. It is important, therefore, to eradicate mesquite *early*—before the grass cover is destroyed.

In tests at Jornada, ARS range scientist C. H. Herbel and range conservationist F. N. Ares have developed methods for eradicating mesquite—based on the degree of infestation—from the 23 million acres of infested land in New Mexico and west Texas.

According to the researchers, treatment with 25 percent fenuron pellets is by far the most effective method for land infested with stands of up to 70 plants per acre (with a canopy of about 48 inches in diameter). Application requires one gram of 25 percent fenuron pellets—about a level teaspoon—per foot of canopy diameter. The pellets must be applied just prior to or in the early part of an expected rainy season—from June to about August in the Jornada area. In the Jornada tests, plant kills since 1958 have ranged from 67 to 94 percent. Costs per acre for herbicide and application varied from $0.39 to $2.46—depending upon the size and number of plants. A bag, a spoon,

A level teaspoon of 25 percent fenuron pellets (one gram active ingredient) is applied per foot of canopy diameter to each mesquite plant. Cost per acre varies with the number and size of plants.

Herbel (left) and Ares chart vegetation trends with a meter square quadrant. The trends are used to relate livestock stocking to weather.

TOP—Large mesquite dunes dominate this area, now a veritable wasteland. Once mesquite plants become established, spring winds blow sand into dunes around plants, grasses die out. BOTTOM—Located about a mile from the infested area, this grassland still provides cattle grazing.

and a horse are all the scientists need to apply the pellets.

Other methods tested for control of honey mesquite are—

Hand Grubbing: Developed for areas where there are up to 50 plants per acre (with canopy of not more than 36 inches in diameter), this is perhaps the most economical method, the scientists say, especially if labor is readily available. Because of mesquite's ability to re-sprout, plants must be severed below the root bud zone, located 4 to 6 inches beneath soil surface. Good supervision is important, to avoid missed plants and to reduce costs (AGR. RES., December 1958, p. 12).

Ground Spraying: This particular method was developed by J. J. Norris and K. A. Valentine, range management specialists at the New Mexico Agricultural Experiment Station. High kills can be obtained during good spray years (when winter-spring precipitation is high) if plants are sprayed to a point of drip with 1¼ pounds of 2,4,5-trichlorophenoxyacetic acid, mixed in 100 gallons of water. Labor cost can make this method expensive. Herbel and Ares have, however, developed a broadcast ground sprayer with a 50-foot boom that lowers application costs 50 percent below those of a two-gun sprayer used previously. Costs for spray and application per acre now average about $1.20. The percentage of plants killed varies with weather conditions year to year.

Aerial Spraying: Herbel and Ares say this method is the most economical for eradicating dense stands. The recommended treatment is ½ pound of 2,4,5-trichlorophenoxyacetic acid, 5 pints of diesel oil, and 4¼ gallons of water for each acre to be sprayed. A second spraying is required in about 3 years. Costs per acre for each application average about $2.00. In the Jornada tests, plant kills varied from 4 to 35 percent with one spraying, and from 22 to 59 percent with two. As in ground spraying, effectiveness depends upon the weather. ARS range conservationist F. H. Tschirley of the Arizona Agricultural Experiment Station, Tucson, assisted in developing this treatment.

Both ground and aerial spraying must be made when the mesquite plants are fully leafed and growing vigorously, and when there is available moisture in the soil, the researchers point out.

Herbel and Ares also are experimenting with mechanical brush control and reseeding methods. Rootplowing, disking, mechanical grubbing, and bulldozing all have been found effective. Costs, however, are excessive unless excellent stands of such native grasses as black grama (*Bouteloua eriopoda*), Lehmann lovegrass (*Eragrostis lehmanniana*), and Boer lovegrass (*Eragrostis chloromelas*) can be established as part of the same operation.☆

Fight Insects with Mist

Aerial spraying with only a few ounces of undiluted (technical) insecticide per acre, generally regarded as a real milestone in reducing the cost of insect control, has one drawback. It often is unsuitable for treatment of acreages cultivated by small farmers.

In one attempt to overcome this handicap, ARS scientists at Florence, S.C., have assembled a sprayer that allows low volume insecticide application to be made with ground equipment.

By permitting application of smaller amounts of insecticide, the new equipment not only saves time, money, and handling, it also reduces the total amount of insecticide used and therefore minimizes the amount of residue that can accumulate on crops or in soil.

Entomologists H. M. Taft and A. R. Hopkins, working with the South Carolina Agricultural Experiment Station, conducted preliminary studies with the experimental ground sprayer on cotton plots during the 1965 growing season. It may also be used on other crops. In early-season tests, the low-volume ground sprayer controlled cotton insects at least as well as aerial application.

Costing approximately $750, the ground sprayer combines already available mechanical parts that can be mounted on most high clearance sprayers or modified farm tractors. It can also apply insecticides at conventional rates.

The ground equipment uses the same mini-spin nozzles that revolutionized aerial spraying, making it possible to disperse as little as 3 ounces of insecticide per acre. With aircraft, the nozzles break up the undiluted material into fine particles, which are then dispersed by the air stream set up by the plane's forward motion. On the ground equipment, the air stream is produced by a conventional mist blower (see photo).

Cotton was treated weekly early in the season, then every 5 days. A similar schedule was followed using conventional equipment on check plots.

Plots that were treated with 12 fluid ounces of technical malathion per acre had only 5 percent as many boll weevils in mid-season cotton squares as the untreated plots. And besides controlling a light infestation of bollworms, the treatment greatly reduced numbers of aphids and mites per terminal leaf—from 92.4 and 226.7, respectively, in the untreated plots to 0.2 and 0.05 in the treated plots.

Similar results were obtained on the four pests when the low-volume equipment applied technical methyl trithion (6 fluid ounces per acre); a technical malathion-technical carbaryl suspension (18 fluid ounces per acre); and a technical malathion-TDE suspension (32 fluid ounces per acre).

Taft and Hopkins also used the equipment to disperse material generally thought to be unsprayable. Carbaryl, a finely ground powder, was suspended in No. 70 spray oil and applied at a rate of 1 pound per acre in 43 fluid ounces. The mixture controlled boll weevils and bollworms. In some experiments, which were still underway, the scientists added indopol polybutene to the mixture in an attempt to make carbaryl adhere to the plant longer.

In the aerial spray tests, technical malathion was applied at 4 to 8 fluid ounces per acre in 75- and 100-foot swaths to control boll weevils. Bollworms were not controlled at these rates, however. In later applications, weevils, bollworms, aphids, and possibly mites were controlled when the scientists upped the rate to 12 fluid ounces per acre, applied in 50-foot swaths. Control of boll weevils, aphids, and mites was also good with early aerial application of 6 fluid ounces and later application of 12 fluid ounces of technical methyl trithion in 75-foot swaths. Bollworms, again, were not controlled.

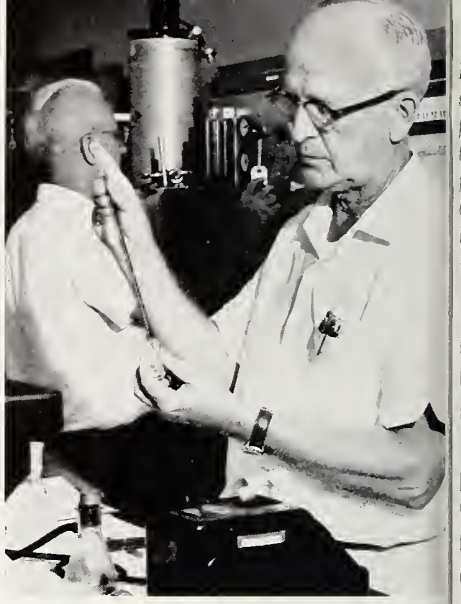
Both aerial and ground sprays were generally comparable in boll weevil control to that achieved in a plot in which a Guthion-DDT standard spray had been applied conventionally.☆

Mini-spin nozzles are attached to a conventional mist blower, one nozzle above each air stream. This unit is then mounted on the chassis of an ordinary high-clearance sprayer.

With an assist from the pig

FAT ANALYSIS

New technique uses enzyme from pigs—aids medical researchers, plant breeders, biochemists



EDITOR'S NOTE: *R. W. Riemenschneider, who directed the research discussed in this article, received a USDA Superior Service Award last May for "outstanding contributions to agriculture, industry, and medicine through the development and improvement of research for determining detailed fatty acid and glyceride composition of fats and oils (AGR. RES., June 1965, p. 8).*

■ The pancreas of the pig secretes an enzyme, lipase, that is being used by ARS scientists to analyze lard and a wide variety of other animal and vegetable fats—with an eye to their improvement.

The technique is proving valuable also to medical researchers in studying fat metabolism.

The enzyme is particularly useful in research because it consistently breaks down (hydrolyzes) specific parts of the fat molecule, thereby yielding structural information that cannot be obtained through ordinary chemical analysis.

First discovered by French chemists, hydrolysis of fats with pancreatic lipase has been refined into a precise analytical tool by scientists at the Eastern utilization research laboratory, Philadelphia. Under the direction of R. W. Riemenschneider, they found that after a fat is subjected to the action of the lipase, the products of the hydrolysis can be separated and analyzed through chromatography (see "Fat Analysis, How It's Done").

Experimental use of the technique has shown it to be extremely precise on known triglycerides. An analysis of fat can be made on a sample as

Fat Analysis --How It's Done

■ The basic chemical components of fats are fatty acids, carbon compounds that vary widely in chain length and may be either saturated (no double bonds) or unsaturated (double bonds). When three of these fatty acids are attached to a glycerol molecule, they form a triglyceride. They may be three identical fatty acids or any combination of two or three different acids.

The physical properties of a fat such as lard are dependent, not only on the fatty acids composing its triglycerides, but also on their arrangement—that is, which acids are attached to the No. 1 position on the glycerol, which to the No. 2, and which to the No. 3.

Although ordinary chemical analysis can identify the fatty acids, it cannot provide this important structural information. Here is where the pancreatic lipase becomes a valuable tool; it selectively hydrolyzes only the fatty acids on the ends of the triglycerides, those at positions 1 and 3.

The ARS researchers found that for an accurate separation of the acids, the hydrolysis must be carried out very rapidly at a temperature of about 40° Centigrade (104° F.). Speed is important because, with time, there is a tendency for some of the acids to shift their position on the glycerol. The scientists found it necessary to shake the solution rapidly (3,000 strokes per minute) to get immediate contact between the fat molecules and the enzyme.

Temperature control is also critical; too much heat tends to destroy the enzyme, too little keeps the fat in a solid or semi-solid state unfavorable to hydrolysis.

After the hydrolysis, the solution contains monoglycerides with their single fatty acid attached at the 2 position and free fatty acids that have been hydrolyzed from the 1 and 3 positions. These can be separated and recovered by thin-layer chromatography. Then after a step in which the fatty acids in each group are converted to their methyl ester form, they are identified and determined quantitatively by gas-liquid chromatography.☆

R. W. Riemensehneider prepares a sample of fat and lipase (foreground) for the shaker, whieh provides thorough hydrolysis. Final step in fat analysis—identifying aetual fatty aeids present—is performed by S. P. Herb through gas chromatography (baekground).

small as 5 milligrams—under conditions established by Riemenschneider and his researchers.

This small-sample analysis makes it possible for—

- Medical researchers to analyze the fat in minute samples of blood and other tissues in studies of fat metabolism. They are using the technique to determine the effect of disease on fat composition and structure.
- Plant breeders to determine the composition and structure of the fat from a single seed, leaving the remaining seeds of a plant for subsequent analysis at later stages of growth.
- Biochemists and other scientists to study and compare the structure and composition of the fat of various animals.

Work by Riemenschneider's group has shown, for example, that the internal and external body fat of pigs differs structurally from that of lambs, dogs, rabbits, beef cattle, chickens, and deer.

(A higher percentage of palmitic acid, a 16-carbon saturated acid, occurs in the No. 2 position in triglycerides of lard than in any of the other animal fats.)

The researchers say that refinement of the fat analysis technique for use on minute samples may lead to some significant discoveries about the biosynthesis of triglycerides. By analyzing the fats of internal organs and other body parts, they might be able to determine how these fats are synthesized in living tissues.

Such knowledge would be of obvious medical and nutritional significance.☆

Scientist studies role of mineral imbalances in bringing about

PARAKERATOSIS IN HOGS

■ Although zinc deficiency directly causes parakeratosis, a troublesome disease with hogs, the deficiency isn't always a simple matter of not enough zinc in the diet to meet minimum nutritional requirements.

Parakeratosis in hogs, which results from rare cases of mineral imbalance, causes hard scabs on the skin. And, what is worse for the farmer's pocketbook—it brings about much slower gains and reduced feed efficiency.

Nutritionists have known for some time that high levels of calcium or phosphorus can tie up zinc in diets containing adequate levels of this mineral. Recent feeding trials with rats, conducted at Beltsville by biochemist C. A. Cabell, brought into sharper focus the delicate interrelationships of mineral requirements.

The ARS trials showed that high levels of calcium and phosphorus can independently interfere with zinc utilization by the body—but calcium poses the greater problem. The worst combination is a diet that oversupplies both calcium and phosphorus.

Cabell also included potassium in this study because earlier research with rats had implicated a deficiency of this element in abnormal hair growth. He thought perhaps potassium deficiency might be tied to the relationship between low zinc and high calcium and phosphorus. The trial, however, showed that potassium deficiency was a separate problem.

Since the physiology of rats is similar to that of hogs, these findings have significance for manufacturers of hog feed, showing more clearly than before that the rather small quantities of calcium and phosphorus required in hog rations must be measured out carefully and accurately.☆

Small size and shaggy haireoat (rat at right) resulted from a defieieney of zine in the diet. The other rat had enough zinc in its diet to meet minimum requirements.

A SOLAR STILL...for survival

Basic research by ARS physicists yields a practical way to get water from desert soil

■ A simple solar still can be set up—in less than 15 minutes—that will extract enough drinking water from desert soils and plants for emergency survival. It uses the two most abundant resources of the desert—sun and soil.

An outgrowth of basic ARS soil and water research, the still can also be used to obtain water from ocean beaches or other places having moist soil but no fresh surface water.

The only equipment required to build the still: A wettable-plastic sheet about 6 feet square, a cup—or container fashioned from the plastic, a rock, and something with which to dig.

R. D. Jackson and C. H. M. van Bavel, research physicists at the U.S. Water Conservation Laboratory, Tempe, Ariz., devised the solar still after doing studies on water-vapor movement through dry soil.

The still uses solar energy to condense water from the underlying soil or from native plants. As much as 2 or 3 pints of water can be obtained daily—even from dry-appearing desert soil. And many desert cactuses have concentrated water supplies that can help boost the solar still's yield.

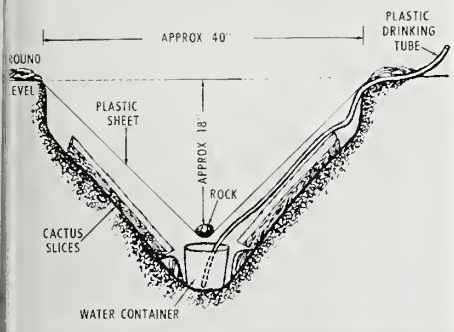
To make the still, dig a bowl-shaped hole in the soil about 40 inches in diameter and about 18 to 20 inches deep. Cover the hole with the plastic sheet and hold it in place with soil around the edges. Place a rock in the center of the plastic to form an inverted cone that follows the contour of the hole but does not touch the soil.

Water drops, drawn up from the soil by solar energy, condense on the underside of the plastic, run to the point of the cone, and drip into the cup or plastic container placed directly under the rock.

R. D. Jackson measures water from a still that yielded 3 pints its first 24 hours of operation. The tube and receptacle, used in the research, are not necessary equipment to the operation of the still.

If the soil is very dry, the yield of water can be further increased by placing cut pieces of cactus or other plants in the hole under the plastic. Polluted water can also be purified by pouring it on the soil under the plastic.

The researchers tested the still in typical desert terrain near Tempe. Yield was about a quart of water per day for the first 5 days from a still located in a dry stream bed. On higher ground, the still yielded about three-quarters of a pint per day; when pieces of succulent cactus—prickly pear, barrel, and saguaro—were added to the hole, the yield increased to 3 pints per day.☆



HERE'S HOW YOU CAN BUILD A SOLAR STILL: With a sharp rock, dig a cone-shaped hole about 40 inches across and 18 inches deep (top left). Then place a piece of aluminum foil—shaped to collect water—in the center of the hole (top right). Next, line the hole with barrel cactus—other succulent cactuses, such as prickly pear or saguaro, will do equally well (bottom left). Finally, drape a plastic sheet over the hole. Anchor and seal the sheet around the edges with soil, and place a rock in the center of the plastic (bottom right). Make certain that the plastic does not touch the cactus or the walls of the hole. Moisture will then condense on the underside of the plastic and trickle down onto the aluminum foil.

By making sample cuts, a sugarcane grower can determine the best topping height for a particular variety of cane in a given year. The topping height influences the percentage of sugar in juice extracted from the cane, and this, in turn, affects the price he will receive.

TOPPING SUGARCANE

The key to more income for growers during early harvest season

■ By careful topping, a sugarcane grower can increase the selling price of the cane he delivers to the sugar mill early in the harvest season.

Normally, he cuts off the tops just below the highest node on the cane. Research indicates, however, that a lower topping height may be more profitable at the beginning of harvest.

Growers cut off cane tops before harvest because the tops contain watery juice with low sucrose content. If these tops are harvested, the watery juice dilutes the sugary juice in the rest of the cane—thus reducing the value of the crop.

If cane is topped at the normal height early in the season, several inches of green, watery top may be left. Later in the season, when the cane is more mature, normal topping usually removes all the green top.

From research at Houma, La., L. G. Davidson, ARS agronomist, concluded that topping height varied from one variety of cane to another and from year to year.

This means a standard recommendation cannot be given in terms of inches of top to remove. Davidson suggests another approach: top early cane so that the harvested part has about 11 percent sucrose, as assayed at the mill. In the Houma tests, cane topped to produce juice with about 11 percent sucrose consistently made the most valuable crop.

One variety (C.P. 44–101) produced the most valuable crop in 1962 when it was topped 24 inches below normal topping height. The same variety in 1963 produced the most valuable crop when it was topped 12 inches below normal topping height. In both cases, the juice contained about 11 percent sucrose.

The price a grower receives for his sugarcane is based on the percentage of sucrose in the juice solids and on the percentage of sucrose in the total juice. The higher both percentages are, the more value the cane has per ton. When the grower cuts off the tops of the cane, he cuts off the part with watery juice. But if the grower cuts off too much of the top, he will lose cane that has a high sucrose percentage and at the same time will reduce tonnage.

The best way for the grower to tell how much of the cane to top is to make a sample cut. He should top a small plot at the normal height, harvest the cane, and send it to the mill. If the juice contains less than 11 percent sucrose, another sample plot should be topped about 12 inches lower than the first. The second cutting should also be analyzed for sucrose content.

Sometimes a third sampling is necessary.☆

Improving Cottonseed Meal

for hen laying rations

■ Poultrymen may soon be able to feed cottonseed meal without worrying about discoloration of egg yolks, caused by gossypol in cottonseed. Recently developed experimental lines of cotton do not have glands that contain gossypol.

ARS scientists say it may be possible to make meal from the glandless cottonseed that will not cause yolk discoloration—even if the eggs are stored for as long as 6 months.

Since the test was made on a limited scale, because only a small quantity of meal processed from glandless seed was available, results are not yet conclusive. ARS poultry husbandman B. W. Heywang and biochemist M. G. Vavich of the Arizona Agricultural Experiment Station conducted the experiment.

The cottonseed meal used in the tests is obtained from strains of cotton which are relatively free of darkly pigmented, speck-size glands containing gossypol (AGR. RES., August 1964, p. 5). Besides causing egg yolk discoloration, gossypol is toxic if consumed in large amounts. Production of a gossypol-free strain of glandless cotton, one that compares favorably with commercial varieties of glanded cotton, would open new markets for cottonseed meal without requiring the expensive removal of gossypol.

Heywang and Vavich tested two samples of glandless cottonseed meal. Oil had been extracted in the laboratory from one sample by screwpress and from the other by hexane, an organic fat solvent. Subsequent analysis showed that the meal processed by hexane extraction had a 0.4 percent fat content, and that by screwpress had 5.8 percent.

When used as 10 percent of the laying ration, neither glandless meal produced any yolk discolorations, even in eggs stored 3 to 6 months.

When 20 percent of the ration consisted of glandless cottonseed meal, however, differences between the two meals became apparent. Of the eggs produced after the hexane-extracted meal was fed at the 20 percent level, 7 percent showed yolk discolorations at the end of 3 months and 24 percent at the end of 6 months. There was no yolk discoloration following either storage period when screwpress-extracted meal was fed.

The whites of stored eggs, on the other hand, were discolored much less frequently when hexane-extracted meal was used. Although pink whites occurred in *some* eggs produced after the hexane-extracted meal was fed, *all* eggs had pink whites when screwpress meal had been included in the diet.☆

Cottonseed meal used in the tests was made from glandless cottonseed (left). Seeds of this strain are relatively free of the darkly pigmented, speck-size glands that contain gossypol. Glanded cottonseed (right) contain gossypol.

WAX BARS

A new technique for controlling sesbania in soybeans

■ A novel 2,4-D application technique that kills sesbania but leaves soybeans untouched has been perfected by an ARS plant physiologist.

The technique: Mount bars of wax containing 2,4-D on tractor booms that are set just high enough to clear the soybeans, then drive through the field. Since sesbania grows taller than soybeans, the treated wax rubs off onto the weeds and kills them—leaving the crop unscathed.

C. G. McWhorter perfected the technique at Stoneville, Miss., in cooperative research with the Mississippi Agricultural Experiment Station.

Sesbania—also known as coffeeweed, coffeebean, and curly indigo—creates severe weed problems in soybeans on thousands of acres in the Delta of Arkansas, Louisiana, and Mississippi. The most troublesome infestations occur on clay soils, where preemergence herbicides are often ineffective. In addition, sesbania seed can germinate and emerge as seedling from depths of 4 to 6 inches in middle

LEFT—One week after treatment with 2,4-D, wax fragments remain on the main stem of a sesbania plant. RIGHT—Three weeks after treatment the sesbania plants begin to wither and die. The troublesome weed creates severe problems in soybeans on thousands of acres in the South.

Suspended from a rear-mounted boom of a tractor, wax bars containing 2,4-D are adjusted 2 to 3 inches above soybean plants—at a point where they rub the taller sesbania plants. Rear mounting avoids transfer of 2,4-D to the tractor and then onto soybean plants.

and late summer. Thus, this broadleaf weed creates a seasonal problem even when good preemergence control measures are practiced.

Preliminary trials at Stoneville in 1962 showed that 2,4-D wax bars would effectively control sesbania without causing injury to soybeans. Additional tests were conducted in 1963 and 1964 on the various sizes and types of wax bars, 2,4-D levels, and tractor speeds. Farmers tested the bars on 20,000 acres of soybeans in Mississippi in 1964.

McWhorter reports that the best results were obtained by using wax bars that weigh 6 pounds, are 22 inches long, contain 1 pound of 2,4-D, and have a melting point of 170° F. Six of these bars, spaced 2 to 3 inches apart, end-to-end, will cover four soybean rows. Optimum tractor speed is about 4 miles per hour—wax bars wear too rapidly at speeds as slow as 1 to 2 m.p.h., and may be physically damaged at speeds above 4 m.p.h.

When weeds are treated before they reach a height 3 feet above the soybeans, cost of a single treatment varies from $0.75 to $1.50 per acre.

The boom holding the wax bars must be mounted on the rear of the tractor. If mounted in the front, there is a possibility that the 2,4-D may be rubbed from the weeds onto the tractor and in turn be rubbed onto the soybean plants, thereby damaging them.

Additional research is being conducted at Stoneville to determine if the wax-bar method can be adapted for control of other broadleaf weeds in soybeans and in other crops.☆

For transpiration-resistance studies

A Portable Sensing Device

■ An ARS physicist has developed a portable, easily operated instrument to measure a plant's resistance to transpiration, the process by which water vapor leaves a plant.

For the first time, it is possible to take a direct measurement of resistance to transpiration in the field without appreciably altering the plant's environment.

C. H. M. van Bavel of the U.S. Water Conservation Laboratory, Tempe, Ariz., designed and built the sensing instrument.

Plants transpire by diffusion. Water escapes leaves through the stomates and cuticle; because there is more moisture in the air inside the leaves than outside, the water seeks to attain equilibrium.

The new sensing instrument consists of two connected units:

- A small plastic cup containing a lithium chloride humidity-sensing element that clamps onto a plant leaf and reacts to transpiration moisture.
- A transistorized, battery-powered resistance meter that records the reaction of the sensing element.

A researcher using the instrument measures the time—often much less than 1 minute—that it takes a plant leaf to transpire a predetermined amount of moisture. This time rate is compared with the time rate of unrestricted transpiration—for instance, the evaporation from a saturated blotter paper held at a temperature similar to that of the leaf. The transpiration resistance is then computed from a simple chart.

A measurement of transpiration resistance has both scientific and practical value. Transpiration resistance is directly related to the size, number, and movement—opening and closing—of stomates, van Bavel explains, and these characteristics determine a plant's water-use efficiency and drought resistance.

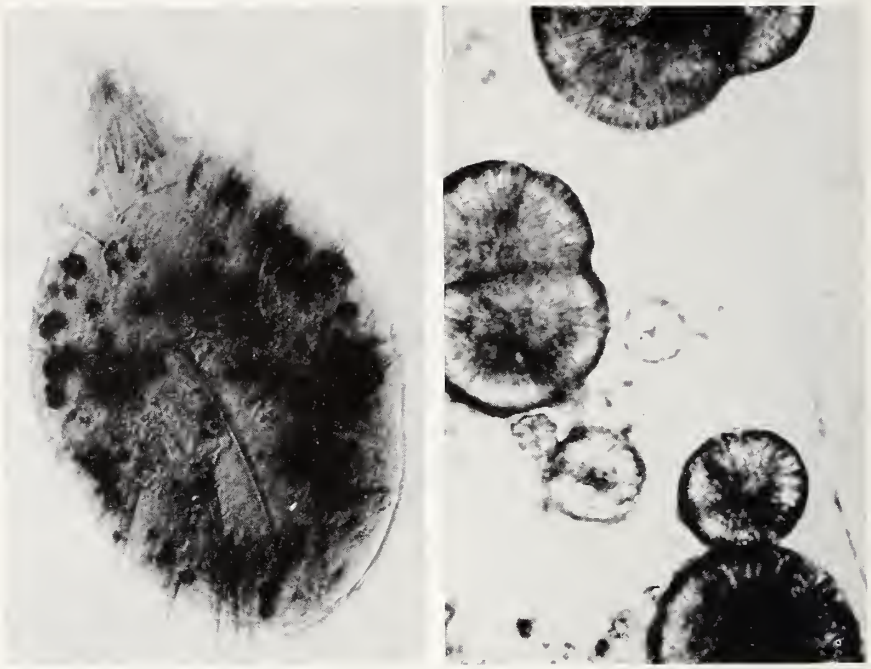
The instrument can also be used to measure the effectiveness of chemical antitranspirants now used to protect plants from water loss during shipment.

The complete instrument can be made from about $100 worth of parts and weighs about 1¾ pounds.☆

Portable sensing instrument, which weighs less than two pounds, simplifies greatly the measuring of resistance that plants have to transpiration. It is transistorized and battery powered.

To aid the citrus industry, entomologists study still another biological control method

Virus Against Mites



Citrus red mite, infected with virus, has crystalline inclusion bodies that are visible in photomicrographs—in the mite (left) and much enlarged (right). Citrus red mites are destructive pests to the citrus fruit industry in California.

■ ARS scientists have reduced populations of citrus red mites in California orchards by infecting the mites with a virus disease.

This biological control method is promising, the scientists say, but more tests must be conducted to determine its full potential. The citrus red mite, the most destructive pest of California's citrus industry, is resistant to nearly all of the organic acaricides.

Entomologists J. E. Gilmore and Francis Munger found the disease and started the mite virus tests in 1958 at Whittier.

In making the tests, the scientists spread the disease by spraying natural field populations of mites with water suspensions containing ground-up infected mites. They also introduced live infected mites into the field populations, a practice that is especially effective against relatively low-density populations of the mite.

To obtain virus for field spraying, the scientists reared mites in the laboratory on green lemons, sprayed them with virus in a water suspension, collected infected mites after 8 to 12 days, and stored them at −10° F.

Researchers were able to trace direct relationships between their treatments and the seriousness of mite infestations. The natural mite populations remained low for more than a year when applications of the virus were made at 6-week intervals. Treatments were deliberately abandoned in two tests to permit the mite populations to increase. As soon as infestations had reached economic importance, treatments again were made, and the populations quickly dropped below the level of economic importance.

Although the scientists can show that their virus treatments were responsible for preventing outbreaks of mites in the test areas, they were unable to accurately compare the effects of varying dosages of virus material. Neither could they compare the effects of various numbers of laboratory-infected mites introduced (100, 1,000, or 10,000 per tree). Some of the experimental procedures will be revised in future tests to get more precise and meaningful results.

The next step in the research will involve field testing in larger plots, with varying dosages at a number of different intervals to determine the most efficient treatment.

Further study is necessary to determine whether the virus is specific only to the citrus red mite or if it can be used against other pests, too. Scientists know it is ineffective against the two-spotted mite and certain related species, some predacious mites, and the citrus rust mite. But they hope it may attack the European red mite, a serious pest of deciduous shrubs and trees—especially plums, prunes and apples.

The investigators will test the virus against this destructive pest.☆

Best irrigation cited for safflower

Seven irrigations produced more safflower seed per inch of water applied than any of several irrigation treatments tested in recent ARS-Arizona studies.

Highest yield per inch of water occurred on plots that were irrigated whenever 65 percent of the available moisture in the top 4 feet of soil was depleted. The plots receiving seven irrigations—6 inches of water each—reached this depletion level approximately every 2 weeks.

Safflower is an economically important crop in Arizona and southern California; about half of the U.S. crop is grown in these two States. But it is also a heavy water user, and late in its growing season—June and July—it must compete with cotton for available irrigation water.

Agricultural engineer L. J. Erie tested eight irrigation treatments on safflower between December planting and July harvest. All test plots received preplant irrigation, then individual plots were irrigated from three to nine times after planting. Arizona's branch experiment station at Mesa cooperated in these basic water-use studies, which will aid county agents and State experiment station workers in recommending irrigation for safflower.

There were no significant differences in total yields between plots that received seven, eight, or nine irrigations, although there were differences of as much as 10 inches in the amounts of water applied to and used by the crop in the irrigation tests.

Plots that received seven, eight, and nine irrigations averaged 105.6, 88.5, and 85.9 pounds of seed per inch of water used. These rates also produced the heaviest seed, with the highest oil content.

Unless sufficient water is applied throughout the growing season, Erie says, safflower could become a marginal crop. The plot that received six irrigations, with the last one about 7 weeks before harvest, for example, yielded 700 pounds less seed per acre than the plot that received seven irrigations. A plot receiving five irrigations yielded over 1,000 pounds less.

New inbred lines for millet hybrids

A recently developed pearl millet inbred that is male sterile may provide better millet hybrids for Africa and India.

The inbred, Tift 18—A and B lines, was developed by ARS and the Georgia Coastal Plain Experiment Station at Tifton. Seed of these two lines is being released to plant breeders, primarily for use by institutional and commercial breeders in Africa and India, where pearl millet is an important food crop. ARS plant geneticist G. W. Burton points out that use of Tift 18A and B in F_1 hybrids should greatly increase yields of grain and maintain or improve the quality of bread and porridge made from it.

Tift 18A carries complete male-sterility required to breed high-quality hybrid seed. Both lines carry a dormancy trait that causes freshly harvested seed to germinate poorly. This trait could be an advantage; it would reduce damage caused by seeds germinating in the heads during rainy periods. Both lines also produce large heads and white seeds, which are desired by farmers in Africa and India.

CO_2 mist speeds plant growth

Spraying lettuce and chrysanthemums with a solution of carbon dioxide gas dissolved in water has caused them to develop more rapidly in preliminary ARS-Kansas studies. Scientists believe the faster growth results from the concentration of carbon dioxide gas around the plants. (Plants use carbon dioxide in photosynthesis, retaining the carbon for food material and giving off oxygen.)

Agricultural engineers G. R. Mowry of ARS and R. I. Lipper of the Kansas Agricultural Experiment Station, Manhattan, noted this phenomenon in greenhouse studies of the two plant species. The work was originated by horticulturist W. J. Carpenter, Jr., of Kansas State University, who is continuing in the research.

In preparing for the tests, the scientists devised a spray system with a carbonator unit very similar to those used at soda fountains. They set the controls to spray automatically for 6 seconds out of every 6 minutes between 9 a.m. and 2 p.m. on clear days only. For checking purposes, plants were sprayed under the same test conditions, except that noncarbonated water was used in the spray.

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Results clearly favored the carbonated spray. After 45 days, lettuce plants sprayed with carbonated water had fresh weights about three times greater than the check plants. Chrysanthemums (Indianapolis White) sprayed with carbonated water had blooms ready for cutting in 57 days; those sprayed with noncarbonated water required 71 days.

Besides supplying more carbon dioxide, carbonated sprays cool the plants and may help them to thrive at higher air temperatures than are now used in greenhouses.

To conduct further basic studies on how the plants are using the carbon dioxide received in the spray, the researchers will use special plant growth chambers (AGR. RES., December 1964, p. 7). By allowing close control of the atmospheres, the chambers should provide answers to a number of technical questions which arose during the preliminary tests.

The scientists will also use a new carbon dioxide gas analysis system to monitor continuously the concentration of the gas in the greenhouses and plant growth chambers.

Beef gullets curb mink litters

Slaughterhouse waste containing gullets of beef carcasses can contain enough natural thyroid hormones to cause reproductive problems in mink that eat these trimmings.

Physiologists at Beltsville, Md., and the New York and Michigan Agricultural Experiment Stations cooperated in research that led to this unique finding.

The study on mink feed started because some mink ranches had been plagued with low birth rates, small litters, and early deaths of many young kits. It seemed that an excess of thyroid hormones could be the cause, since the mink were eating slaughterhouse waste containing a high percentage of gullets to which the thyroid glands might still be attached.

After the research team found substantial amounts of thyroid hormone in the gullet trimmings, they set out on a three-part feeding trial:

- One group of mink received a diet excluding gullet trimmings but including the amount of extracted hormone found in a normal portion of gullet trimmings.
- A second group was fed on a usual diet including gullet trimmings.
- A third group received neither trimmings nor extract in the feed.

The diet without gullet trimmings and extract caused no reproductive troubles. Poor reproduction by mink on the diets with trimmings or extract added clearly implicated thyroid hormones as the cause.

Co–ops: Partners in American life

Cooperative month will be observed nationally during October, built around the theme, "Cooperatives-Partners in American Life."

ARS will be among agencies participating in a week of USDA activities scheduled to begin October 5 in Washington, D.C.

Special emphasis is being placed on the role of cooperatives in providing high-quality consumer goods and services, job opportunities, credit, supplies and technical services to farmers, community leadership, and electric power and telephone systems for small towns and rural areas.

ARS provides a continuous flow of information—through its four regional utilization laboratories—to cooperatives to keep them abreast of new and improved methods of utilizing agricultural materials and byproducts.

Many products developed through ARS utilization research are now available to consumers through the efforts of cooperatives. To name a few, these include apple juice concentrate, redi-wheat, instant sweetpotatoes, dehydrated alfalfa, and processed pine gum.

Included in USDA's program are a keynote address by Secretary Freeman on October 5; seminar on International Cooperatives Credit on October 7; seminar on Cooperative Communications on October 8; and panel discussions on housing and agricultural cooperatives, vocational education, and credit unions.

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